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ROYAL AIRCRAFT ESTABLISHMENT

TECHNICAL REPORT 71242

COMPARATIVE ASSESSMENT OF AIRCRAFT-TO-WEAPON COMMUNICATION SYSTEMS

by

WORKING GROUP 11 OF WORKING PANEL 0-4 OF TTCP

PROCUREMENT EXECUTIVE, MINISTRY OF DEFENCE
FARNBOROUGH, HANTS

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SUBJECTS
1. Aircraft equipment
2. Aircraft
3. Radio Units
4. Subsystems
5. Weapons

UDC 623.451.74 : 623.454.25 : 629.13.064 : 629.192.5 : 629.192.6

ROYAL AIRCRAFT ESTABLISHMENT

Technical Report 71242

December 1971

THE TECHNICAL COOPERATION PROGRAMME

REPORT OF WORKING GROUP II TO THE WORKING PANEL O-4 OF TTCP, ON THE SUBJECT OF AIRCRAFT TO WEAPON COMMUNICATION

by

WORKING GROUP II OF WORKING PANEL O-4 OF TTCP

SUMMARY

The Working Group, comprised of members from the USA, Australia, Canada and the UK, surveyed existing and proposed aircraft to weapon fuze selection systems. After a comparative study of the advantages and disadvantages of the various systems, recommendations were made which might influence the design of future aircraft/weapon interfaces. Among these was the proposal that consideration might well be given to the inclusion of a screened, balanced pair in the standard wiring loom as aircraft development permits.

Departmental Reference: WE 219

(The title of this Report is unclassified)

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1 INTRODUCTION

Following the meeting of the TTCP-04 Working Panel in UK in June 1971, Working Group II was tasked "to survey in depth the various approaches being considered for the communication between an aircraft and weapon fuze selection system; to list the respective advantages and disadvantages and to recommend likely areas in which compatibility could be achieved".

This survey was completed at meetings in the USA in October 1971 and is reported below. Representatives of the four nations concerned participated.

The detailed survey of present systems and of the more important proposed systems is based on descriptive papers which have either been published generally (the present systems) or have been presented to the 04 Working Panel at full meetings. References to these papers are appended.

2 SYSTEMS CONSIDERED

Consideration was given to the following systems:

Multi-wire systems: (Generally one wire in US and two wires in UK systems.)

dc/RF - a basic dc system carrying a RF ripple for selection purposes.

dc - the basic dc selection system.

dc and chopped dc - Ref.3

Magnetic aircraft weapon link - Ref.1.

Digital fuze selection system - Ref.6.

Mechanical interconnection analogue systems - Systems in which a selector movement in the aircraft is transferred through a mechanical interface to the weapon.

Electrical analogue systems - Systems in which a selector movement in the aircraft is transferred through an electrical interface to the weapon.

Free transmission X-ray, γ-ray and RF aircraft/weapon interconnection links have been considered in the past and have been omitted from further serious consideration at this time. It is generally considered that further advancements in the state-of-the-art would be necessary before practical application could be considered feasible. However, development of balanced pairs, coaxial cable and fibre optic direct transmission systems show some promise. Some details of specific systems falling into the above classifications are given in the references listed.

3 COMPARISON OF SYSTEMS

In order to draw up some sort of a comparison between the various existing or proposed future systems a number of factors have been listed which are associated with fuze selection system merits or demerits (Table 1). Some of these factors are environmental (such as the influence of temperature on performance) while others such as cost, safety or system capacity are not. These factors are, of course, not of equal importance. A table has been drawn up comparing the relative merits of the various systems under each factor heading. A 'rating' number has been chosen from the range 1-5 for each system where 1 implies a high degree of merit which will fulfill all known immediate future requirements. Number 5 on the other hand indicates a poor performance which could impinge on Service usefulness. It is worth noting that these numbers do not indicate in themselves the order into which the systems fall - for example, if all the systems fall somewhat short of a practical ideal (e.g. in maintainability) then no number 1 will be scored.

Where experience has been gained of systems in Service, then a judgement has been based on that experience (i.e., columns dc/RF and dc). Where the systems are not yet in Service, judgement has been based on development experience to date plus an assessment of expected behaviour.

One or two specific observations about the meaning of the various factors listed may be worth making.

Electromagnetic susceptibility is taken to mean susceptibility to internal or external RF in flight but excludes Electromagnetic Pulse associated with a nuclear explosion in the vicinity. This consideration is included in the factor 'nuclear hardness'.

Reliability is considered in its broadest sense and in an operational rather than peacetime environment.

Transformation speed refers to resetting time between weapon drops - perhaps in a mixed stick.

The number of weapons controlled is the number of weapons receiving signals rather than the variety of differenct types of weapon.

Growth potential has been judged from the point of view of the latitude given by the fuze selection system in question to future weapon designers faced with new weapon design problems in the fuzing field.

Weight and size is difficult to judge in absolute terms of what is achievable but the numbers have some relative value.

Aircraft compatibility is intended to assess the ease with which a whole range of existing or future aircraft can be accommodated.

Cost includes the cost of the onboard control or selection box, the permanent aircraft installation and any expendable decoder or conversion unit sited in the weapon. No attempt has been made to assess the relative value of the expendable and non-loss components.

4 OBSERVATIONS AND RECOMMENDATIONS

Working Group II recognize that it is not their function to recommend any particular weapon/aircraft interconnection system for use in future aircraft. They also recognise that arrangements to standardize between future national flying Services would be negotiated through the appropriate standardization committees. However, their discussions of future trends in the design of aircraft/weapon fuze control systems have shown that a warning should be sounded that long term consideration should be given to the provision of appropriate aircraft/weapon connectors by aircraft designers and those responsible for preparing aircraft electrical system specifications.

Factors which may induce a change in the design of the aircraft/ weapon interface are:

(a) The possible need to drop a mixed load of weapons in a single pass over a target (e.g., airfield attack and also airfield denial weapons) and the increased selection flexibility available in new weapons.

(b) The increasing possibility of using digital systems to transmit nav/attack data round an aircraft can be expected to lead to the need for some use of a digital or other electronic communication system from aircraft to weapon in the not too distant future. This channel might carry GW prelaunch guidance data and also fuze option selection signals which could change up to the instant of launch if aircraft heights, etc, demanded S&A setting changes.

(c) The use of numerous parallel wires between cockpit and weapon stations entails the permanent carriage of a heavy weight of cable loom. This weight could be greatly reduced by the use of say one or two cables

carrying time multiplexed coded signals. This factor, is of course, more significant in aircraft nuclear weapon systems than in conventional ones.

(d) The use of swing-wings and rotatable pylons accentuates the penalties of heavy cable looms.

The 04 Working Group II therefore feels that these trends, which have manifested themselves in consideration of possible future fuze selection systems, may have wider implications in the aircraft installation field and merit a broader and deeper study. It is further considered that this study should cover helicopter systems in addition to fixed wing and variable geometry aircraft and be applicable to past, present and future weapons. The Working Group has been unable to propose any unique way in which present aircraft armament systems could be adapted to give wider future use. Future systems (in particular the digital systems) have not yet reached a stage of development which enables a clear definition of the interconnection requirement to be made. However, consideration might well be given to the inclusion of a screened, balanced pair in the standard wiring loom as aircraft development permits. This would then enable aircraft to operate a wide variety of coded high frequency fuze and other selection systems. A wide flexibility of coding forms and transition modes would then be open to weapon designers provided that this interface is accepted as standard.

Table 1

SYSTEMS COMPARISON

dc/RF	dc	dc chopped	Mawl	Digital balanced pair	Analogue (mech)	Analogue (elect)	Influencing factors
5	3	1	1	1	2	2	Temperature
3	2	1	2	2	4	3	Vibration
5	2	2	1	4	1	2	EM susceptibility
3	2	2	3	2	3	2	Release disturbance
5	5	3	2	3	1	2	Nuclear hardness
4	2	2	2	4	2	3	Reliability
3	2	1	2	1	1	2	Safety
3	3	3	3	1	4	2	Transformation speed
5	2	2	3	1	4	3	No of weapons controlled
4	5	2	3	2	5	4	Growth potential
5	5	3	3	1	4	3	Self check
3	2	2	3	2	4	3	Weight and size
3	2	2	3	2	4	2	Producibility
5	3	3	2	4	4	4	Maintainability
3	1	1	3	3	4	4	Compatibility (new/old aircraft types)
2	4	2	3	1	3	2	No of selections available
3	2	3	5	2	5	5	Cost
In service		Not in service					

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